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A Fourth Catalogue of 47 *New Double Stars, discovered with a* 6-*inch Alvan Clark Refractor.* By S. W. Burnham, Esq.

The double stars forming the following list have been discovered since the observations embraced in the Third Catalogue which appeared in *Monthly Notices* for December 1873. During a considerable portion of this interval the weather has been exceedingly unfavourable, and the number of new objects found is much smaller than it should have been, judging from former results, with a larger and the usual proportion of clear nights.

These stars have all been found with the same instrument previously used, with the single exception of *τ Orionis*, the duplicity of which was discovered with the 18½-inch refractor of the Dearborn Observatory.

I have measured most of the position-angles; when estimates are made only, the angles have (±) attached to them. In the absence of a suitable driving clock nothing could be done in measuring distances, and the angular measures have been obtained with more difficulty, and doubtless with less accurate results, in consequence of the want of driving machinery. Many of them, however, are very close, or very unequal and difficult of measurement, even with every advantage.

In the following list the distances of thirty are not more than 2″, and many of that number are down to 1″ and less. Several pairs of Struve, Herschel, and others have been found to be again closely double, and some of them are very difficult and interesting objects.

In my last Catalogue, No. 113 was entered as not having been well seen, although there was very little doubt of its being double. Not long since I found this again, independently, and readily recognised it as a double star, but it is an extremely difficult pair.

The places are reduced to 1880. The numbers attached are continued from my former Catalogues in *Monthly Notices* for March, May, and December, 1873.

No. 183 = L 3487.

R.A. = $1^h\ 47^m\ 21^s$ Decl. = −17° 20′

P = 240 ± D = 2″ Mags. 8½, 11.

A pretty pair in *Cetus*, *n f a*, 6th mag. star. Position-angle not measured. Discovered December 9, 1873.

No. 184 = L 8474.

R.A. = $4^h\ 22^m\ 34^s$ Decl. = −21° 46′

P = 270°·5 D = 1″·2 Mags. 7, 8.

A very elegant pair in *Eridanus*, and not very difficult under favourable conditions. The angle was measured when the star

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was not well seen, and is, therefore, not very accurate. December 14, 1873.

No. 185 = L 8745-6.

R.A. = $4^h\ 31^m\ 25^s$ Decl. = − 15° 10′
P = 241° D = 3″ Mags. 8, 11.

In *Eridanus*, 38′ *s* of 53 *Eridani*, and $1^m\ 17^s$ *f.* Easy and rather unimportant pair. February 17, 1874.

No. 186 = L 8986.

R.A. = $4^h\ 40^m\ 10^s$ Decl. = − 7° 12′
P = 180° ± D = 1″·7 Mags. 8, 10.

A more difficult and much finer pair in the same constellation. No opportunity occurred to measure the angle. December 14, 1873.

No. 187 = L 9397.

R.A. = $4^h\ 54^m\ 9^s$ Decl. = + 14° 20′
P = 270° ± D = 1″ Mags. 8 = 8.

A close double star on the borders of *Orion* and *Taurus*. It is 2^m following, and 1′ 44″ south of the wide triple, H. V. 113. The latter appears to be identical with H. V. 57 (= Sh. 49 = Σ C.P. 148). The new pair is an interesting object. January 11, 1874.

No. 188 = τ *Orionis*.

R.A. = $5^h\ 11^m\ 47^s$ Decl. = − 6° 58′
(A and D = H.V. 25 = Σ C.P. 167 A and B = H 2259)

A and B, P = 250°·4	A and D, P = 63°·8	B and C (new), P = 55° ±
D = 18″ ±	D = 18″ ±	D = 2″
Mags. 4, 14	Mags. 4, 12	Mags. 14, 16.

The duplicity of the smaller companion to τ *Orionis* was discovered with the Chicago 18½-in. refractor, December 22, 1873. I was examining the trapezium of *Orion* for the new stars alleged to have been seen within it, and upon directing the instrument to this star saw at once that the companion discovered by Sir John Herschel was double. The second star of the close pair is much smaller, and might easily have escaped attention from an observer not specially interested in double stars. I am not at all certain that the distance is as great as 2″, and it may not exceed 1″·5, but, not being very familiar with the eyepieces, my estimate is entitled to less credit than in the other pairs in this list. The measures of B and D, given above, are from Sir John Herschel's Fifth Catalogue of Double Stars, where this companion, as a single star, is first noticed. It is singular that it should have been missed by Herschel I., as with my 6-in. refractor it is very obvious

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under almost any circumstances. My instrument, of course, fails to show the close star. I do not know how large an aperture would be necessary, but probably at least 12 or 15 in. would deal with it under the best conditions. The only similar object of the kind in the heavens heretofore observed is α^2 *Capricorni*. The duplicity of Herschel's 16 mag. companion to that star was discovered by Mr. Alvan Clark, while the 11½-in. refractor was in his possession (and independently, but with the same instrument, by myself at Chicago). Prof. C. A. Young was able to see the companion double, with the 9·4 in. Dartmouth College refractor, on the Rocky Mountain Expedition, at an elevation of about 9,000 feet above the sea. He estimated the distance of the components as $1''\cdot 5$. This agrees nearly with my estimate at the time of finding it. I am not aware of its ever having been seen with any other instruments. Both of these minute double companions should be observed and measured, for there is every *appearance* of physical connexion, and they may prove as interesting as they are (with ordinary instruments) difficult. I may add here that I could not see the slightest trace of any stars within the trapezium. This is the second time I have examined it with the large telescope under favourable circumstances, when a star of one-tenth the light of the 6th star could not have been overlooked. The failure of this instrument, and the new 26-in. refractor, at the U. S. Naval Observatory, as well as other larger apertures, to show any of the stars claimed to have been seen with much smaller instruments, renders it almost certain that they do not really exist. The theory of variability cannot account for such failure where the object has been so carefully and frequently observed.

No. 189 = *Orionis* 81.

R.A. = $5^h\ 14^m\ 32^s$ Decl. = $-5^\circ\ 29'$

P = $285^\circ\cdot 0$ D = $5''$ Mags. 7, 15.

This is the *s f* of two bright stars about 1½° *n* of τ *Orionis*, The companion is excessively minute, and generally it is a very difficult object. When measured, however, it was very well seen, and the measures fairly accordant. The companion seemed to have a reddish tint. February 9, 1874.

No. 190 = *Orionis* 82.

(A and C = Σ 692 = H. IV. 87 = S 475)

R.A = $5^h\ 14^m\ 38^s$ Decl. = $-8^\circ\ 9'$

P = $360^\circ \pm$ D = $0''\cdot 5$ Mags. 8, 8.

The principal star of this wide pair is a very close and exceedingly difficult double. The elongation appeared to be very nearly in the direction of the distant star. The difficulty of the object fully accounts for it being overlooked by Struve, Herschel, South, and others, who have observed and measured A and C.

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No change has taken place in that pair. Struve (1831·5) gave P = 4°·2; D = 34″·86; mags. 8·8. Engelmann (1863·1), P = 3°·9; D = 35°·58. February 9, 1874.

No. 191 = *Arg.* (+ 34°) 1033.

R.A. $5^{h}\ 17^{m}\ 19^{s}$ Decl. = + 34° 27′

P = 204° D = 2″ Mags. 9, 9.

A not very interesting pair of small stars $2^{m}\ 52^{s}$ *p* and 7′·8 *n* of Σ 707. The latter has a second minute companion, not mentioned by Struve. April 12, 1874.

No. 192 = τ *Aurigæ.*

(A and C = H.V. 21 = Σ C.P. 205)

R.A. = $5^{h}\ 40^{m}\ 52^{s}$ Decl. = + 39° 8′

A and B P = 360° A and C P = 32°·5

D = 25″ D = 60″

Mags. 5, 14 Mags. 5, 12.

I am not acquainted with any measure of Herschel's companion made heretofore. The new companion is exceedingly faint, and rather less than half the distance of the other. It is too minute for reliable measures. January 4, 1874.

No. 193 = Weisse VI. 208.

R.A. = $6^{h}\ 9^{m}\ 10^{s}$ Decl. = + 4° 0′

P = 90° ± D = 15″ Mags. 8, 15.

Another very faint companion, and only seen by careful attention. There is a second brighter companion, 62″ distant, in the direction of 225°. January 11, 1874.

No. 194 = *Arg.* (+38°) 1537.

R.A. = $6^{h}\ 28^{m}\ 4^{s}$ Decl. = + 38° 6′

P = 283°·5 D = 1″ Mags. 8, 8½.

A very pretty pair, at first taken to be OΣ 147. That was entered in Otto Struve's Catalogue of 1850 with a distance of 0″·6, with two bright distant companions. Dembowski, in 1865, found the close pair single, as it is now. The star is perfectly round, with a power of 400. The new pair is $1^{m}\ 58^{s}$ *p* and 4′ *s*. The three stars in OΣ 147 form an equilateral triangle; the side being about 45″, and the stars being nearly the same brightness, it is a striking object. Possibly the pair I have noted was the one observed by Otto Struve, and in some way confounded with one of the stars of this wide triple. April 2, 1874.

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No. 195.

R.A. = $6^h\ 37^m\ 7^s$ Decl. = $-23°\ 8'$

P = 214° D = 5″ Mags. 7, 12.

A very unequal pair is *Canis Major*. Measures not very good. March 4, 1874.

No. 196 = Weisse VII. 142.

R.A. = $7^h\ 6^m\ 27^s$ Decl. = $-5°\ 14'$

P = 200° ± D = 14″ Mags. 9, 10.

The last of a line of three stars in the same field; a rather faint and insignificant object. February 16, 1874.

No. 197 = L 14026.

R.A. = $7^h\ 7^m\ 0^s$ Decl. = $-6°\ 57'$

P = 150°·6 D = 2″ Mags. 8, 10.

A pretty pair in *Monoceros*, and readily seen. February 17, 1874.

No. 198 = L 14503.

R.A. = $7^h\ 20^m\ 36^s$ Decl. = $-20°\ 43'$

P = 212° D = 3″·5 Mags. 8, 11.

A very fine pair in *Canis Major*. The primary is decidedly red. The pair of 10^m stars 40^s *p* and 4′ *s* is H 3964. March 4, 1874.

No. 199 = L 14480.

R.A. = $7^h\ 19^m\ 57^s$ Decl. $-20°\ 56'$

P = 19° D = 1″·2 Mags. 7, 9.

An elegant double star just south of H 3964, mentioned in the note to the last. There is a distant 9 mag. companion in the direction of 301°. March 4, 1874.

No. 200 = 70 *Geminorum* = H. VI. 70.

R.A. = $7^h\ 30^m\ 41^s$ Decl. = $+35°\ 19'$

A and B,	A and C,	C and D (new),
P = 188°·3	P = 98°	P 249°
D = 98″	D = 160″	D = 1″·5
Mags. 6, 11	Mags. 6, 9½	Mags. 10, 12.

Sir William Herschel entered 70 *Geminorum* in his Class VI. of double stars without measures, with estimated distances of each 60″±. I do not know that these distant companions have ever been measured. The results given above are from my own observations. The most distant of the two companions is a close double of more than ordinary difficulty, and requires very

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careful attention, even in good weather, to be well seen. The measures, though made with as much care as possible, may not be very close. February 17, 1874.

No. 201 = L 14945.

R.A. = $7^h\ 33^m\ 41^s$ Decl. = − 20° 0′

P = 330° D = 2″-4″ Mags. 8, 8.

A very easy pair in *Argo*. The distance was not carefully estimated. April 10, 1874.

No. 202.

R.A. = $7^h\ 56^m\ 59^s$ Decl. = − 26° 53′

A and B, P = 162° A and C, P = 248°

D = 6″ D = 15″

Mags. 7, 14.

A very unequal double, with a more distant companion, C, preceding. March 21, 1874.

No. 203.

R.A. = $7^h\ 57^m\ 40^s$ Decl. = − 27° 14′

P = 246°·5 D = 5″ Mags. 7, 10.

A fine pair in *Argo*. There is a 9 mag. companion 64″ distant in the direction of 73°·7 (+180°?). Herschel has a double, H 4037 (*Cape Obs.*) not far from this place, which I could not find. The angle and distance are both larger than in this pair, so they can hardly be identical. March 22, 1874.

No. 204 = L 16074.

R.A. = $8^h\ 7^m\ 2^s$ Decl. = + 10° 45′

P = 304°·8 D = 1″ Mags. 7½, 11.

An excessively difficult pair, 31′ 48″ *s* of the binary, Σ 1202. The closeness and great inequality of the components render this a very troublesome object to observe, except under favourable conditions. March 27, 1874.

No. 205 = Pyxis 9 (Bode).

R.A. = $8^h\ 27^m\ 54^s$ Decl. = − 24° 7′

P = 130° ± D = 0″·5 Mags. 7, 7.

Very close and difficult, but finally pretty well seen. An attempt was made to measure it, but the definition was too poor at the time to make the results much better than an estimate. March 12, 1874.

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No. 206.

R.A. = $8^h\ 30^m\ 17^s$ Decl. = − 24° 42′

P = 278°·6 D = 1″·5 Mags. 8, 9.

Another fine pair in the same vicinity as the last. This is the following of two stars nearly in the same parallel, $1^m\ 22^s$ apart. March 12, 1874.

No. 207 = L 17091.

R.A. = $8^h\ 33^m\ 44^s$ Decl. = − 19° 19′

P = 99° D = 5″ Mags. 6½, 11.

A splendid pair; the primary red, and companion apparently blue. February 16, 1874.

No. 208 = L 17103 = Pyxis 17 (Bode).

R.A. = $8^h\ 33^m\ 54^s$ Decl. = − 22° 16′

P = 30°·4 D = 1″·4 Mags. 6, 9.

This exquisite pair was found in focussing the glass for No. 205. It is a naked-eye star, and rated 6 mag. in Argelander and Heis. There is a distant companion in the direction of 215°; D=72″. Nos. 205, 206 and this pair are in the same neighbourhood, and were found within a few minutes of each other. March 12, 1874.

No. 209 = Weisse VIII. 849.

R.A. = $8^h\ 35^m\ 24^s$ Decl. = + 39° 14′

P = 355°·5 D = 1″·6 Mags. 8, 8½.

A pretty but very easy pair found in determining the correct place of Σ1259, the decl. of which in *Positiones Mediæ* is 10′ in error.

No. 210 = L 17696.

R.A. = $8^h\ 51^m\ 18^s$ Decl. = − 16° 58′

P = 182°·5 D = 2″·3 Mags. 7½, 7½.

A pretty pair of nearly equal stars. February 16, 1874.

No. 211 = *Hydræ* 68.

R.A. = $8^h\ 55^m\ 42^s$ Decl. = + 3° 9′

P = 255°·6 D = 1″ Mags. 7, 10.

A splendid, but exceedingly difficult pair, in the same field with Σ 1302. The components are close and very unequal, and the best circumstances are requisite for a separation of the discs. The measures were apparently good, and accordant. Σ 1302, an easy pair of small stars, is 43^s *p* and 4′ 16″ *n*. The new pair is L 17831. April 9, 1874.

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No. 212 = *Hydræ* 95.

R.A. = $9^{h}\ 10^{m}\ 12^{s}$ Decl. = − 7° 51′
P = 218°·5 D = 1″·5 Mags. 7, 9.

Another very elegant pair 23′ 32″ *n.* of 24 *Hydræ*, and 37^{s} *p.* The distance not very carefully noted, but measures good. The star is L 18296-7. February 4, 1874.

No. 213 = L 18648.

R.A. = $9^{h}\ 22^{m}\ 25^{s}$ Decl. = − 7° 34′
P = 185°·5 D = 1″·5 Mags. 8½, 10.

This difficult pair is 34′ 31″ north of *a Hydræ*, and is a more difficult object than the last, as both components are much smaller. February 13, 1874.

No. 214 = L 19064 = *Felis* 15 (Bode).

R.A. = $9^{h}\ 35^{m}\ 52^{s}$ Decl. = − 17° 56′
P = 263°·9 D = 2″·5 Mags. 7½, 11.

A very pretty pair, and not difficult. March 12, 1874.

No. 215 = *Lacaille* 4058.

R.A. = $9^{h}\ 48^{m}\ 41^{s}$ Decl. = − 27° 26′
P = 340° ± D = 1″·5 Mags. 7½, 11.

An elegant, but excessively unequal and difficult double star. Occasions when so severe a test can be well seen so far south are comparatively rare, and no opportunity occurred after its discovery to obtain a satisfactory measure of the angle. March 26, 1874.

No. 216 = *Lacaille* 4074.

R.A. = $9^{h}\ 51^{m}\ 20^{s}$ Decl. = − 25° 59″
P = 177° D = 2″·5 Mags. 6½, 13.

This is one of the most difficult stars of its class in this list. The companion is so minute a point as to require the most careful attention. It is more difficult than the last, which was found a few minutes before on the same evening; but measures were taken at once of this pair, when it was seen much better than at any subsequent time. The places of both are taken from the Washington *Catalogue of Stars.* March 26, 1874.

No. 217.

R.A. = $10^{h}\ 1^{m}\ 16^{s}$ Decl. = − 24° 8′
P = 273°·5 D = 1″·5 Mags. 7½, 7½.

Another very fine pair, found the same evening as the two

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preceding. The stars are nearly equal, and being only moderately close, it is much less difficult than the others. Place from the Washington *Mural Circle Zones.* March 26, 1874.

No. 218 = L 19765.

R.A. = $10^{h}\ 1^{m}\ 40^{s}$ Decl. = − 19° 7′

P = 109°·5 D = 1″ Mags. 8, 8.

The preceding star of a small equilateral triangle. A beautiful, but difficult pair. March 10, 1874.

No. 219 = *Felis* 54.

R.A. = $10^{h}\ 15^{m}\ 57^{s}$ Decl. = − 21° 56′

P = 193°·6 D = 2″ Mags. 7, 9.

Another elegant double in the same neighbourhood. The 10″ pair of 8½-in. stars about 4′ south is H 4303 (*Cape Obs.*) This star in Bode 6 mag. March 10, 1874.

No. 220 = *Crateris* 22.

R.A. = $11^{h}\ 6^{m}\ 34^{s}$ Decl. = − 17° 51′

P = 147°·7 D = 0″·5 Mags. 6, 6.

A most elegant double star is *Crater.* It is given as 5 mag. in Bode and Lalande, but 6 mag. in Argelander and Heis. The angle given is a mean of two sets of measures, fairly accordant, considering the closeness of the pair. In Bode this star is designated ψ *Crateris.*

No. 221 = L 24532.

R.A. = $13^{h}\ 6^{m}\ 54^{s}$ Decl. = − 14° 49′

P = 49°·4 D = 1″·5 Mags. 8, 10.

This unequal pair is 43′ north of 53 *Virginis*, and is moderately difficult. March 26, 1874.

No. 222 = L 24636.

R.A. = $13^{h}\ 10^{m}\ 55^{s}$ Decl. = − 20° 54′

P = 10° D = 1″·5 Mags. 8, 10.

Another pair in *Hydra*, similar in distance and magnitude to the last. March 26, 1874.

No. 223 = L 25350.

R.A. = $13^{h}\ 38^{m}\ 58^{s}$ Decl. = − 2° 43′

P = 342°·8 D = 18″ Mags. 8, 11.

A wide pair, found in looking for a double near the same place, discovered by Winnecke (*Astron. Nach.* 1738). The latter

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is a pair of $9\frac{1}{2}$ mag. stars, 4″·68 apart. The distance seems to be rather less now, and if a rough measure of the angle is not considerably in error, it has diminished since Winnecke's measures in 1855. May 12, 1874.

No. 224 = Weisse XIV. 95.

R.A. = $14^h\ 7^m\ 37^s$ Decl. = + 13° 8′

P = 73° D = 0″·7 Mags. $8\frac{1}{2}$, $8\frac{1}{2}$.

An excessively difficult pair in *Boötes* 35′ north of O Σ 269. Measured, but results disagree much. May 6, 1874.

No. 225 = χ Turdi Sol.

(A and B = H N. 80 = Sh. 179 = Σ C.P. 459)

R.A. = $14^h\ 7^m\ 47^s$ Decl. = − 19° 26′

A and B (South),		B and C (new)	
	P = 295°·8		P = 103°·4
	D = 35″·12		D = 1″·5
	Mags. 7, $7\frac{1}{2}$		Mags. $7\frac{1}{2}$, 9.

It is remarkable that the duplicity of B should have escaped the Herschels, South, Jacob, and others, who have observed the wide pair, if it was then as easy as it is now. It could hardly be missed now if examined with any instrument of not less than 4 or 5-inch aperture, under favourable conditions. The wide pair is evidently fixed. Jacob (1847·7) found P = 295°·7; D = 35″·23. For the same pair I obtained, P = 295°·8. The measures of the close pair are very satisfactory, and the result of two nights' observation, the first giving 103°·3, and the second 103°·5. This star is L 26319-0. May 12, 1874.

No. 226 = L 26665.

R.A. = $14^h\ 32^m\ 4^s$ Decl. = − 21° 49′

P = 70° D = 1″ Mags. $7\frac{1}{2}$, $7\frac{1}{2}$.

A fine but close and difficult pair in *Scorpio*. May 13, 1874.

No. 227 = B.A.C. 5039.

R.A. = $15^h\ 12^m\ 7^s$ Decl. = − 23° 50′

P = 184°·1 D = 1″·7 Mags. 7, $10\frac{1}{2}$.

This fine pair is the middle one of three stars in the same field, and nearly following each other. This was found in looking for H 4759, a suspected close pair. (*See note to next No.*) May 6, 1874.

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No. 228 = B.A.C. 5041 = H 4756.

R.A. = $15^h\ 12^m\ 38^s$ Decl. = − 23° 50′

P = 329° D = 0″·8 Mags. $7\frac{1}{2}$, $7\frac{3}{4}$.

Herschel has entered this pair in *Cape Observations* as follows: P = 180° ±; D = $\frac{2}{3}''$; Mags. 9·$9\frac{1}{2}$ with the note "Requires verification." On the first examination I took No. 227 to be this star, with a considerable error in Herschel's distance, but upon observing the following star again, I saw at once that it was a close pair, and undoubtedly the one suspected by Herschel, although the magnitudes and position-angle do not correspond very closely, and his decl. is 1′ too small by the place in B.A.C. and Washington *Catalogue*. It is singular that he should have missed the other pair which is in the same field, 31^s *p*. May 12, 1874.

No. 229 = L 45726.

R.A. = $23^h\ 14^m\ 26^s$ Decl. = + 56° 35′

P = 37° D = 12″ Mags. 8, 11.

A wide and unimportant pair in *Cassiopeiæ*. January 15, 1874.

Chicago, 1874, *May* 12.

Note on the Double Star, Σ 707. By S. W. Burnham, Esq.

Dembowski, in 1864, in his measures of Struve's double stars, observed this pair, as he supposed, but found two pairs near each other, of which his measures are as follow:—

	°	″		
Preceding in R.A.	P = 51·6	D = 28·62	Mags. 9·5	10·5
Following in R.A.	P = 328·9	D = 20·88	Mags. 9·3	10·0

The measures of Σ 707 in the *Mensuræ Micrometricæ* are P = 131°·6; D = 18″·29; Mags. 8, 10·2. Dembowski has this note:—"On voit deux doubles dans le champ de la lunette, à peu de distance l'une de l'autre. Il y a certainement un fort changement, mais laquelle des deux doubles est la Σ 707 mesurée par Struve?" (*Astron. Nachr.* 1572). Obviously Struve's pair could not be either of the stars observed; and upon a recent examination I found that Dembowski's pairs are in a low power field with Σ 707, the following one of the two being about 38^s preceding. These stars are all too faint and wide to have any special interest. I found a second companion to Σ 707, not noticed by Struve. It is